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EFFECT OF HEAT STRESS AND NUTRITION STATUS ON WORKER FATIGUE AT TRADITIONAL MUSIC GAMELAN INDUSTRY

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ABSTRACT

Background: *Industry of gamelanproduction is informal industry from motherhood heritage of Java. Making gamelan worker direct heat exposure and consume large man power, thus need good physic stamina especially in heatting process.*
Aims: *This study aim to know the effect of heating stress and nutrition status on worker fatique.*
Method: *This study conducted by observation, quesionare, documentation and measurement. Respondents were 30 gamelan-producing workers at forging process dan finising process from 105 populationwithpurposive sampling in Wirunvillage Sukoharjo Central Java Indonesia.Measurement of heating stress using area heat stress tool. Status of nutrition was measured by body weight weighing, while the fatique was measuded by timer reaction tool. Statistic analysis with linear regression.*
Results: *Results showed that heating stress in forging process part has Wet Bulb Globe Temperature(WBGT) average 31°C (>threshold value) and and at finishing process part has WBGT average 27,9 °C (≤threshold value), that means in heatting process was more fatigue compared to in finishing process. Linear regression statistical test with p-value 0.008 (≤0,05) showed there is effect of heat stress on worker fatigue.There was relationship between nutrition status and work fatique, where worker with good status of nutrition have no fatique of 6.67 %, low fatique of 50%, and medium fatigue of 6.67 %. All of worker with low status of nutrition getting fatigue, whereas worker with excessive nutrition status also getting fatigue by medium fatigue of 20 % and high fatigue of 6.67%. Linear regression statistical test with p-value 0.04 (≤0,05) showed there is effect of nutrition status on worker fatigue.*
Conclusion: *Workers in forging site more likely to experience work fatigue than workers in finisshing site. There is effect of heat stress on worker fatigue. There is significant association between nutritional status and work fatigue.*

Keywords *: Gamelan Industry, heating stress, nutrition status and fatigue.*

INTRODUCTION

Industry of gamelan production in Wirun Village, Sukoharjo, is a home industry that processing raw materials such as tin and brass into gamelan musical instruments.The process of gamelan making is started with mixing the raw materials such as copper and tin within ratio 3: 1 for bonang and 10:3 for gong as the part of gamelan, heated in the mold, and then mixing it together to form a slab. And then that mixed material burned on fire and forged by workers using heavy hammer that have various weight started from 8 kg-10kg, so that workers need powerful energy to do that job. If the metal temperature decreasing, it should be burned again and forged repeatedly while

occasionally heated to obtain the desired shape. After forging process, there is finishing process such as grinding and sanding.

The heat is generated due to metal forging stage. In this industry, workers work in hot environments derived from the waiting warming on the ignition process before forging metal plates into the desired shaped gong, the heat which was felt by workers was generated by blast furnaces and the closed place. First surveythat heating stress in forging process part has Wet Bulb Globe Temperature (WBGT) 29.6ºC (>threshold value) WBGT is allowed for 75% of working time and 25% of resting with high workload is 25.9 ºC, duration 8 hours everyday, time entry start from 08.00 until16.00WIB.That heatting stress is>threshold value.Workers in hot environments, including around furnancing, smelting, boilers, ovens, stove can suffer heat stress, impacting body to lose heat to maintain the balance between environmental and body, and finally lead to fatigue [9]. Thermal stress (heat stress) is the climaticalwork load accepted by human body [4]. Factors that affecting heat stress is air temperature, air humidity, air movement velocity, heat radiation [8].Workers endurance against heat stress is determined by physiological adaptation acclimatization, worker's age, sex and nutritional status [6]. Heat stress can lead to fatigue, dehydration, prickly heat, muscle cramps, impaired blood flow to the brain, dry mouth, very thirsty, weak, and very tired [9] .

There was a significant relationship / significant between nutritional status and fatigue [3]. Fatigue can be determined using an indicator that showed fatigue caused by work [9]. One of affecting factor of work fatigue is age. The increasing age will be followed by the decreasing of strength and muscle endurance [9]. Work period also affected fatigue. Work fatigue associated with the pressure that occurs while working can be derived from the work task, physical conditions, chemical conditions, and social in workplace. Constant pressure occurred with the increasing of work period together with workers process adaptation in the workplace [10].

METHOD

This research was using observational analytic study with cross sectional approach, applied in area forging site and finishing site of industry of gamelan production in Wirun Sukoharjo. Respondents were 30 workers in gamelan producer at forging process dan finising process from 105 populationwithpurposive sampling. Data collection techniques were using observation, interview, documentation and measurement of heating area using area heat stress too, weight and height are used to determine the nutritional status and fatigue. Nutritional status is worker's weight divided by the square of worker's height. Good nutritional status is if the BMI (Body Mass Index) in the category of normal (18.5 to 25.0) kg / m². Nutritional status is if the BMI (Body Mass Index) in the category of more than> 25.0 kg / m². Malnutrition status is if the BMI (Body Mass Index) in the category of less than <18.5 kg / m². Measuring Instruments that being used are scales and gauges. Work fatigue is a feeling of weary experienced by workers in gamelan industry after work which is measured by reaction timer with 240.0 milliseconds of reaction time. Not tired

Normal is indicated if worker's reaction time workers in between 150.0 to 240.0 milliseconds. Low Fatigue Work is indicated if worker's reaction time in between 240.0 - <410.0 milliseconds. Medium Work fatigue Medium is indicated if the reaction time worker in between > 410.0 - <580.0 milliseconds. High Work fatigue is indicated if the reaction time workers in between > 580.0 milli seconds, as measured by Lakassidaya Reaction Timer Lakassidaya. The results will be compared by standard measurement of fatigue namely: 1) Normal: reaction time 150.0 to 240.0 milliseconds, 2) Low Work Fatigue reaction time> 240.0 - <410.0 milliseconds, 3) Medium Work fatigue Medium (KKS): reaction time> 410.0 - <580.0 milliseconds, 4) High Work fatigue :reaction time> 580.0 milliseconds.Statistic analysis was linear regression.

RESULTS

Based on the research that has been done in the industry of gamelan production in Wirun Sukoharjo obtained that the data of respondent's aged of25 to 50 years old.

Table 1. Characteristics of age and work period of workers in Gamelan Industry of Wirun Sukoharjo.

No	Age		Work period	
	(Year)	(%)	(Year)	(%)
1	25 – 30	10,0%	5 – 10	56,6
2	31 – 35	23,3%	11 – 15	30,0
3	36 – 40	20,0%	16 – 20	6,7
4	41 – 45	20,0%	21 – 25	6,7
5	46 – 50	26,7%		

Tabel 2. Heat stress condition in Gamelan Industry of Wirun Sukoharjo

No.	Time Measurement	WBGT*			
		Forging site		Finishing site	
		Point 1	Point 2	Point 1	Point 2
		(°C)			
1.	09.00	30,8	29,2	27,2	27,7
2.	10.00	32,5	30,5	27,9	27,2
3.	11.00	32,9	30,1	27,9	27,7
	Average	32,1	29,9	27,7	27,5

*WBGT: Wet Bulb Globe Time

From the results of heat stress measurement in the workplace WBGT in forging points 1 and point 2 is 31 ºC (> TLV) and in finishing site point 1 and 2 are 27.6ºC (<TLV).

Figure 1. Workers in forging site while working 75%

Figure 2. Workers in forging site while resting 25%

Figure 3. Workers in finishing site

In the forging site category of high work load because work in door and workers exposed to heat more than the Threshold Limit Value (TLV) is allowed. Sources heat exposure from burner. In the finishing category of medium work load because work out doors only do the sanding and grinding gamelan has been forged and worked in the shade so it is not exposed to direct heat sources

According to Indonesian National Standard SNI 16-7063-2004 about Threshold Limit Values Work Climate (Heat), Noise, Vibration and Arm Radiation and Ultra Violet rays at Work, WBGT is allowed for 75% of working time and 25% of resting with high workload is 25.9 ºC and medium workload is 28ºC. From the results of heat stress measurement in the workplace WBGT in forging

points 1 and point 2 is 31 ºC (> TLV) and in finishing site point 1 and 2 are 27.6ºC (<TLV), which are not in accordance with NAB were allowed to work with heavy workloads and working hours and rest periods 75% to 25%.

By using the linear regression analysis test, the value of p is 0.008 (≤0.05), which means that there is a significant relationship between heat stress and work fatigue.

The results of measurement and calculation showed that 6,67% of workers have malnutrition status, 6,67% of workers have is in good nutrition status and 63,33% of workers have over nutrition status.

The measurements of fatigue conducted after work (before resting time) are provided by table 4.

Table. 4. The percentage rate of fatigue due to work fatigue, poor nutrition status and good nutritional status

Work Fatigue Scale	Good Nutrition Status Frequency	Poor Nutrition Status Frequency	Work Fatigue Frequency[x]	Work Fatigue in Forging Site[y]	Fatigue in Finishing Site[y]
Normal	6,67	0	6,67	53,8	50
Low	50	3,33	56,67	15,4	50
Medium	6,67	3,33	30	30,8	0
High	0	0	6,67	0	0

Note [x]: all workers; [y]: all workers in forging site and finishing site affected by heat stress.

By using the linear rregression analysis test, the value of p is 0.04 (≤0.05), which means that there is a significant relationship between nutrition status and work fatigue.

DISCUSSION

According to Indonesian National Standard SNI 16-7063-2004 about Threshold Limit Values Work Climate (Heat), Noise, Vibration and Arm Radiation and Ultra Violet rays at Work, WBGT is allowed for 75% of working time and 25% of resting with high workload is 25.9 ºC and medium workload is 28ºC. From the results of heat stress measurement in the workplace WBGT in forging points 1 and point 2 is 31 ºC (> TLV) and in finishing site point 1 and 2 are 27.6ºC (<TLV), which are not in accordance with NAB were allowed to work with heavy workloads and working hours and rest periods 75% to 25%. This condition should be controlled by providing an exhaust fan, wearing work clothes made from cotton T-shirts which can absorb sweat easily, provide adequate ventilation for air circulation smoothly, decreasing work load factor, decreasing radiant work load, and providing adequate resting time.

The finishing site is categorizing as average work load category because workers doing the sanding task and grinding task in a shady place, they are not exposed to heat sources directly. In forging site, wokers exposed to heat more than the allowed Threshold Limit Value (TLV. Based on linear regression statistical test, p-value ≤ 0.01 showed there is effect of heat stress on worker fatigue.It goes the same with another research about difference reaction time with light stimuli (fatigue) among workers in forging and molding site PT. Ingenyst Semarang before and after hot place exposure (10). Heat stress also has significant correlation with fatigue among workers in drilling site (7).

Worker's nutritional status condition shows that workers with food nutritional status have the largest percentage by 63.33%. Workers with low work fatigue level have the highest percentage by 56.67%. Sometimes workers who experience lowwork fatigue have a rest and consume drinks or food in their working time.The precentage of workers not experienced work fatigue (normal) is 6.67%. Another several workers experiencing medium work fatigue (30%) and low work fatigue (6.67%) All of workers with poor nutritional status is experiencingwork fatigue whether it is low or medium. It is caused by the worker with the malnutrition status is consuming fewer food, so the amount of nutrients that enter the body is less than the amount of energy expended while working [5].

Many workers with good nutritional status experiencing low work fatigue and few of them experiencing medium work fatigue. There also workers who not experiencing work fatiguee due to the intake of nutrients in the body is proportional to the amount of produced energy [2]. All of workers with over nutritional status experiencinglow, medium and high work fatigue. It is caused by due to their over nutritional status nutritional status, they require greater energy to move along with their weight body. Although they get a much amount of nutrients intake, the process of energy combustion in the body consume its energy according to their body surface area, but also their activities in the workplace [3].

By using the linear rregression analysis test, the value of p is 0.04 (≤0.05), which means that there is a significant relationship between nutritional status and work fatigue. The strength of weak correlation in the relationship between nutritional status and fatigue likely caused by internal factors and external work environment. This is consistent with the theory that the nutritional status is one of the elements that determine the physical quality and quantity of physical labor and therefore contributes to fatigue [11].

Almost all of gamelan industry worker in Wirun Sukoharjo Village have been work more than 5 years, so workers have been well adapted to the job and work environment. Work fatigue associated with the pressure that occurs at work could be derived from the work task, physical conditions, chemical conditions, and social work. Constant pressure occurs along with the increasing work period and adaptation process of workers in the workplace [9].

CONCLUSION

The average rate of heat stress WBGT in forging site is 31ºC (> TLV) and in finishing site is 27,6 ºC (≤ TLV), causing workers in forging site more likely to experience work fatigue than workers in finishing site.There is significant association between nutritional status and work fatigue on gamelan industry workers in Wirun Village Sukoharjo. Controlling heat stress in forging site by installing ventilation for air circulation and installing fan for cooling down workers's body temperature in resting time. Placing drinking water supply inside forging site for workers and workers should drink much water while working in workplace with high heat stress.

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